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ICT-INTEGRATED CLIL FOR DYSLEXIC LEARNERS: IMPROVING LEARNING AND COGNITIVE-MOTOR COORDINATION

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ABSTRACT

In present-day education, the language learning process is transformed into a multisensory process that involves auditory, visual, and physical interaction simultaneously. In this framework, Information and Communication Technology (ICT) integrated Content and Language Integrated Learning (CLIL) provides an innovative and effective pathways to support dyslexic learners who often faces challenges like confusion between similar letters, speech-motor fluency, weak phonological decoding, and problems in recognizing written patterns. The research investigates the potential of ICT-based CLIL activities (digital voice recording, interactive simulation, speech-to-text apps, etc.) to improve speech clarity, enhance multi-sensory engagement, and strengthen the mind-body connection. More specifically, the research explores how ICT CLIL activities improved speech accuracy through continuous listening and self-correction, enhance auditory-motor synchronization through immediate feedback, and develop 'eye-to-hand coordination' through visual and motor engagement. This demonstrates how technology can be a resource for creating an inclusive, engaging, and meaningful learning space. The CLIL theory has the goals of fostering language and content learning at the same time while situations are contextualized and meaningful. The research highlights the benefits of task-structured ICT-CLIL learning, which not only provides feedback on verbal expression, visual tracking, and listening accuracy, but also helps dyslexic students to independently learn, raise their confidence, improve coordination, and create a positive atmosphere within the classroom. Additionally, it can assist in developing skills in language and content knowledge simultaneously.

Keywords: Auditory-Motor Synchronization, Descriptive-Analytical Methodology, Hand-Eye Coordination, ICT Integrated CLIL, and Speech Precision

INTRODUCTION

Dyslexia is described as a neurodevelopmental disorder affecting visual-symbol integration, motor articulation, and phonological processing. In the ESL classroom, dyslexia typically manifests itself as difficulty establishing the consistency of a grapheme–phoneme correspondence, which contributes to slow and inconsistent reading and writing Alves et al. (2018). Issues with motor coordination resulting from cerebellar functioning might affect speech timing and fluency in oral production, which can make speech production seem difficult Barth et al. (2010). While organized music-based rhythm intervention studies have reported large effects in relation to reading, issues with auditory-motor synchronization may have potentially been problematic with phonological awareness and the ability to successfully recognize sound-symbol associations Flaugnacco et al. (2015).

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These days, the use of multisensory learning is indispensable in ESL classes as it assists students to understand and remember the language better when they take part in auditory, visual, and kinesthetic activities that involve multiple senses in a significant, interactive, and intelligible manner Tan et al. (2019). The use of ICT tools is particularly important as deep practice, repetition and practice at the learners' own pace are all established characteristics of practice. Voice-recording and speech-analysis tools for self-tracking learnings' articulation and pronunciation as well as some multimodal phonics platforms that aim to promote and enhance auditory-motor coordination and letter-sound mapping O'Brien et al. (2022). Typing tutors and tactile writing surfaces supports hand-eye coordination and stabilizes new activities associated with developing skills in the new 'literacy', so more efficiently and fluently use English as a second language.

By integrating multimodal ICT tools into Content and Language Integrated Learning (CLIL), learners with dyslexia interact with the learning material and learn language through meaningful interaction rather than memorization Gabillon (2020), CLIL classes naturally reinforced speech clarity, audio-motor coordination, and regulated written output through auditory, visual, and kinesthetic input. The multimodal, content-driven approach reduces cognitive load and builds confidence. Thus, the aim of this study is to investigate how dyslexic ESL learners' articulation, phonological processing, and hand-eye coordination were possibly enhanced by digitally mediated CLIL practices Balta et al. (2022).

REVIEW OF LITERATURE

Dyslexia is a neurodevelopmental disorder that negatively affects the development of fluent literacy in second or additional language contexts through phonological processing, orthographic–phonological mapping, and motor coordination abilities Snowling (2015). Inadequate development of stable grapheme–phoneme relationships leads to slow decoding, poor spelling, and pauses in oral fluency Vellutino et al. (2004). Additionally, these phonological inefficiencies disrupt speech production by undermining auditory-motor integration and reducing phonological memory Ramus and Szenkovits (2008). Procedural learning deficiencies also affect handwriting automaticity and coordination Nicolson and Fawcett (2011) and create even greater challenges for ESL students who are learning to read and pronounce words correctly.

As dyslexia is a disorder that affects phonological processing, visual symbol identification, and motor coordination simultaneously, the classroom support should not be limited to the traditional reading exercises but must include multisensory learning Birsh and Carreker (2018). A number of experiments conducted by Shaywitz and Shaywitz (2020) reveal that methods combining listening, seeing, and movement give children several chances to process the written form and the sound, thus, they extend and solidify the language networks. The connection between hearing and speaking has to be made stronger as it is a match of what they hear and how they produce it that is working spoken English fluency, rhythm, and clarity further Tierney and Kraus (2013).

When multimodal instruction is implemented, i.e. when dyslexic students are taught through a combination of sounds, letters, and movement, information and communication technology (ICT) can play a pivotal role in this process by providing structured digital settings Vouglanis (2023). One of the beneficial aspects of audio-supported tools is that they deliver information in print and sound, which, as a result, improve reading comprehension and make the process of decoding easier Knoop-van Campen et al. (2022). To start with, speech-to-text functions give on-the-spot help which can lead to independent writing skills, at the same time, the use of voice-recording and speech-analysis tools enables learners to listen to their own pronunciation and make it right if it is incorrect Tan et al. (2019). Through such interaction with language, the students are actually experiencing more regular speech patterns and are improving their auditory-motor coordination Zarić et al. (2020).

Such digital interactive simulations provide additional support phonological and motor development in a multimodal, ICT-supported CLIL framework. In general, typing tutors and tracing platforms help the learner to acquire the coordinated motor routines necessary for literacy Dere (2019), while phonics visualizers and pronunciation-mapping tools guide students to establish the connection between sounds and articulatory motions Hismanoglu and Hismanoglu (2011). As these supportive technologies facilitate the establishment of regular motor patterns and reduce the writing effort, they allow dyslexic learners to become more confident in language tasks which are content-focused Koul et al. (2024).

The integration of ICT tools in Content and Language Integrated Learning (CLIL) helps in the creation of meaningful environments where the language is developed through interaction with the subject matter rather than by rote learning. CLIL supports comprehension-led communication through the promotion of language and subject learning that are done concurrently Gabillon (2020). When ICT is used to complement these lessons, learners have more auditory-motor alignment, better visual tracking, more controlled writing, and clearer pronunciation Begimbetova et al. (2022). These conditions work to raise the level of ICT-supported CLIL that can be used to implement authentic language usage and to have the overall learning outcomes improved Balta et al. (2022), O'Brien et al. (2022).

Research, in general, points to the effectiveness of multimodal, digitally mediated environments that support phonological accuracy, articulatory control, auditory-motor rhythm, and coordinated writing for the benefit of dyslexic learners O'Brien et al. (2022). Nicolson and Fawcett (2011) also emphasize that these techniques have the greatest impact on symptoms of phonological decoding, motor timing, and procedural coordination. Still, only a handful of studies have combined these tools into one CLIL

framework that addresses both cognitive-motor and language development Gabillon (2020). The difference between them is that this difference necessitates exploring how ICT-supported CLIL can enhance hand-eye coordination, auditory-motor alignment, and speech clarity in ESL students with dyslexia.

THEORETICAL FRAMEWORK

Dalton-Puffer (2011) states that Content and Language Integrated Learning (CLIL) is a method of instruction that facilitates language growth in a natural way through meaningful academic work. CLIL merges communication, understanding, and content processing into one educational process instead of treating language as a separate skill. The system is founded on the notion that language is most effectively acquired through deliberate use and that it focuses more on real-world tasks rather than on the memorization of patterns Pérez-Cañado (2012). In such situations, students become both subject-wise and language-wise as they evaluate information, give their views, and apply ideas Lasagabaster and Sierra (2010).

The 4Cs model—Content, Communication, Cognition, and Culture—provides a structured way for connecting learning through the topic and purposeful language use, which is based on the understanding of CLIL Nezhyva (2025). In contrast to content that provides a heavy academic focus Xin et al. (2025), communication is primarily concerned with understanding and expressing ideas in an authentic way. Cognitive processes of a higher kind are invited by cognition, and culture, which is very much related to technology in the classroom, helps the inclusive participation, identity, and awareness of the students Vouglanis (2023). These 4Cs are interrelated to guide CLIL to be both conceptual and language development integrated.

CLIL meets the requirements of dyslexic learners. It accomplishes this by lowering the cognitive load since the attention is not on language exercises, but on the subject concepts which the students can engage with in a more meaningful way Barth et al. (2010). Learners take advantage of the context, their prior knowledge, and multimodal input to figure out the meaning when language is infused with content thus they are less dependent on phonological decoding Ramus and Szenkovits (2008). In spite of phonological difficulties, dyslexic learners acquire vocabulary, syntax, and pronunciation idly through a few purposeful activities which are supported by some visual, auditory, and motor scaffolds Dere (2019). The effect of this is a reduction in anxiety and an increase of self-confidence Alves et al. (2018).

Content and Language Integrated Learning (CLIL) through the multisensory engagement of the language provides extra support to the dyslexic learners. When ICT tools are used, learners get combined auditory, visual, and kinaesthetic input, which elevates their articulatory control, hand-eye coordination, and auditory-motor synchrony Flaugnacco et al. (2015). The integration of motor skills and language is improved when the learner's interaction with the content is through speech, writing, visuals, and digital simulations Koul et al. (2024). Repetition that takes place within meaningful tasks, learners internalize language patterns more naturally and they become more confident in expressing their ideas as they move up the supportive environment.

METHODOLOGY

The descriptive-analytical methodology which is the main focus of this research is basically based on conceptual interpretation rather than collecting empirical data. The method allows a step-by-step inquiry of the influence of CLIL environments supported by ICT on the learning experiences of dyslexic ESL learners. By merging theoretical insights with previously published findings, the paper explains how technology-mediated multisensory instruction can help students who are phonologically weak, have articulatory control, and coordination-based issues Guichon (2009).

The study shows how ICT-CLIL through pictures, sounds, and movements altogether helps the brain to learn through all senses. To hear and then do what has been heard and correct oneself, along with the help of a voice recording software, a pronunciation checking program, and an interactive simulation, this cycle brings hearing and speech to the same level Li and Hegelheimer (2013). In this way, digital writing platforms, typing tutors, and tracing tools become more effective in enhancing the visual-motor hand-eye coordination skills by establishing a strong and uniform routine for the visual-motor. When these representations are combined, they reveal the process by which language-processing pathways of dyslexic learners are becoming stronger and their cognitive load is getting lighter through the coordinated sensory input.

They first review academic literature, conceptual models, and technology-based resources to assess the extent to which these can be used in a CLIL framework. The paper demonstrates the role of ICT in eliciting more clear speech, giving more confidence to the learner, and creating easy ways for the integration of language and subject knowledge through the study of the functioning of digital tools in content-driven learning tasks Hismanoglu and Hismanoglu (2011). This descriptive synthesis generates a conceptual framework that depicts ICT-CLIL as a holistic strategy capable of satisfying the linguistic and cognitive-motor needs of dyslexic students in ESL contexts Vouglanis (2023).

ANALYSIS AND DISCUSSION

In their study, Murat Hismanoglu and Hismanoglu (2011) explain that to dyslexic ESL learners, voice-recording and speech-analysis tools can be very helpful in their articulation as they enable them to listen to and evaluate their own speech, something

which they find difficult to monitor during real-time production. The improvement of phonological accuracy and articulatory timing as a result of the repeated listening and self-correction cycles is what basically leads to smoother fluency Ramus and Szenkovits (2008). Moreover, this repeated practice serves as a very comfortable place where the learners can work on their pronunciation independently and thus, pronunciation gets refined O'Brien et al. (2022). Besides that, it also helps learners to solidify the connection between sound and letter through continuous auditory-phonological mapping Alves et al. (2018).

In order to help dyslexic students to understand better, a pronunciation system takes the sound features and changes them to visual patterns and thus the students can more clearly see the patterns and comprehend them Zarić et al. (2020). According to the Sanfilippo et al. (2020), to improve the learners' skills, visual cues like waveforms, phoneme boundaries and pitch contours are suggested which can help learners who have trouble with auditory processing alone by making pronunciation errors visually identifiable. In Content and Language Integrated Learning (CLIL) related activities, students become more aware of speech patterns and gain articulatory confidence Lasagabaster and Sierra (2010) when they compare their output with target models thus they activate their perception and articulation more strongly Tierney and Kraus (2013).

It has been found that when ICT tools provide instantaneous corrective feedback, auditory-motor synchronization improves significantly, thus enabling students to better coordinate the timing between what they hear and what they produce Flaugnacco et al. (2015). In the case of a dyslexic student, who is often a phonological sequencing problem, such an agreement is very important because the real-time feedback serves as a completion of these gaps. The document states that matching auditory input with motor articulation can be a challenge; continuous changes supported by digital cues not only help to increase oral fluency but also facilitate rhythmic control becoming more stable Tierney and Kraus (2013).

Interactive simulations and phonics visualizers give additional help by demonstrating how the movements of the articulatory organs are related to the particular sounds O'Brien et al. (2022). These devices, by motor imitation, complement the auditory input by showing the tongue placement, the airflow patterns, and the mouth configuration. The article states that this multisensory coordination has a positive effect on reading accuracy, oral fluency, and self-confidence during reading aloud or pronunciation practice, as it deepens phonological representations since students can imitate the sounds while looking at their structure Li and Hegelheimer (2013).

ICT-supported writing tools that guide students through structured motor routines not only hand-eye coordination, but also the students' skills in articulatory and phonological visualization. The use of tracing templates, tactile writing surfaces, and typing tutors are all good ways to help movement patterns become more controlled and the mental side of letter formation, spacing and writing rhythm to be less Dere (2019). The report says that dyslexic students are a group that frequently have difficulty in developing their motor skills and hence visual-motor practice can lead to them becoming more automatic Nicolson and Fawcett (2011). Since fine-motor sequenced tasks are most often difficult to perform, digital handwriting scaffolds can provide the needed visual support and repetition very quickly Okuda et al. (2014) and as a result, the writing becomes clearer and more fluent Koul et al. (2024).

Digital CLIL tasks help to develop visual-motor integration as they combine subject content with the physical interaction that has a purpose. It is necessary for learners to visually locate the object of their hand movement while at the same time they have to process the meaning if they are performing actions like labelling a diagram, categorising concepts by dragging them, or matching terms with images O'Brien et al. (2022). Since CLIL promotes a meaningful integration of language and content, this, in turn, improves comprehension and supports literacy development Pérez-Cañado (2012). The paper states that such tasks when used in CLIL not only help to develop the visual processing side of the brain and the orthographic- semantic connections that are very important for dyslexic learners but they also provide motor stability to these learners while they are engaging with academic concepts Zarić et al. (2020).

Overall, when dyslexic students are given a low-stress, multisensory environment for targeted practice, ICT-supported CLIL settings raise the level of both language and cognitive-motor coordination Sanfilippo et al. (2020). Digital tools lessen the discomfort and increase the user's confidence through self-correction, paced engagement, and private rehearsal, which are all promoted by the user Lasagabaster and Sierra (2010). The integration of auditory, visual, and motor pathways is the main support for clearer speech, more stable auditory-motor alignment, and better writing control Barth et al. (2010). ICT-CLIL deepens the processing and makes the engagement more productive by combining the subject knowledge with the intentional use of language Dalton-Puffer (2011), Pérez-Cañado (2012).

CONCLUSION

This study conceptually aimed to explore the potential of ICT-supported CLIL in improving the articulation, phonological decoding, auditory-motor synchronisation, and hand-eye coordination of dyslexic ESL learners. To show how ICT-CLIL offers multisensory support to students suffering from decoding, motor timing, and fluent expression issues, the research employed a descriptive-analytical approach to the interpretation of previous studies. The review of literature revealed that phonological, articulatory, and coordination problems persisted in the case of dyslexic learners while multisensory input—auditory, visual, and kinesthetic—helped not only to stabilize phonological patterns but also to lower the cognitive load during language tasks Snowling (2015).

Moreover, the CLIL theoretical framework suggested that context-based, comprehension-led learning is a natural support for dyslexic learners as it enables them to get the meaning from the subject matter instead of relying heavily on phonological decoding Nezhyva (2025). By integrating communication, content knowledge, and cognitive engagement, CLIL reduces cognitive load and provides rich entry points into language learning. Presenting visual scaffolds, contextual cues, and purposeful tasks, dyslexic learners, therefore, are able to confidently process language through various sensory pathways in a supportive environment.

According to the study, the use of ICT tools in CLIL can bring about positive effects on speech clarity, phonological mapping, and motor coordination through well-planned multisensory practice O'Brien et al. (2022). The use of voice-recording and speech-analysis tools, therefore, enables students to work on their pronunciation independently as one articulatory precision and rhythmic control are facilitated Li and Hegelheimer (2013). Interactive simulations and pronunciation visualisers, through immediate feedback and visual cues, lead to a very close execution of auditory-motor synchronization Tierney and Kraus (2013). Digital tracing, typing tutors, and tactile writing platforms work towards the enhancement of the writing skill through hand-eye coordination and, therefore, these can be done repeatedly through visually guided exercises Koul et al. (2024). All these findings exemplify how ICT-CLIL is a perfect vehicle for coordinating sensory engagement with content learning.

This research addresses a void in existing scientific works by suggesting a descriptive study that merges the areas of the learning process, dyslexia, multisensory ICT tools, CLIL methodology, and coordination-based skill development. It points out that these elements are hardly ever considered together. The paper illustrates how ICT-CLIL can satisfy the language and general cognitive-motor requirements of dyslexic ESL learners by conducting a descriptive-analytical integration of the theories and research pieces most widely accepted. Although it is a theoretical piece, it is a well-grounded theoretical framework for future classroom research projects aimed at generating useful, empirically supported instructional applications.

Simply put, if the different senses are engaged in a well- coordinated manner, ICT-integrated CLIL can be seen as a broad and inclusive model capable of providing the necessary assistance to ESL learners with dyslexia. By integrating less stressful content learning with auditory, visual, and motor reinforcement, this method not only makes a safe space for students to practice language but also gives them more self-assurance. The use of digital feedback, contextual cues, and purposeful tasks helps in the strengthening of articulatory precision, phonological decoding, auditory-motor alignment, and writing coordination. On the whole, ICT-CLIL is very convincing in theory as a potential instrument for the creation of efficient, self-assurance- enhancing ways for language and content learning.

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